ELECTRICALLY ISOLATING THERMALLY COUPLED DEVICE FOR NOISE SUPPRESSION OF CIRCUITS IN DEEP SPACE. T. McNutt[1], A. Mantooth[1], M. Mojarradi[2], H. Li[3], B. Blalock[4], [1]University of Arkansas, BEC 3217, Fayetteville, AR 72701, tmcnutt@engr.uark.edu, mantooth@engr.uark.edu . [2] Jet Prolusion Laboratory, 4800 Oak Grove, Pasadena, CA 91109, Mohammad.M.Mojarradi@jpl.nasa.gov . [3] University of Idaho, Elec. Engr., Moscow, ID 83844, harry@denali.ee.uidaho.edu . [4] Mississippi State University, Dept. of Elec. and Comp. Engr., Box 9571, Mississippi State, MS 39762 blalock@ece.msstate.edu .

Introduction: Mixed mode rad hard avionics Systems on a Chip (SoC)designed for deep space applications such as Europa orbiters and Europa Landers will require data isolation circuits to block noise. This paper presents the simulation performance for a novel rad hard SOI CMOS compatible thermal transducer used for on-chip data isolation in SoC. The research presented involves the use of commercially available CAD tools to model the transient electrothermal behavior of the transducer. Both one- and two-dimensional analyses of a prototype thermal transducer were performed. Results indicate that thermal-based data isolator technology can pass a data bit in under a microsecond and, as a measurement of feasibility I^2C bus specifications can be met.

Definitions of Systems-on-a-Chip (SoC) vary from chips containing primarily complex digital circuitry to those comprised of mixed-signal and even mixed-technology subsystems. This latter definition includes analog/RF circuitry and MEMs devices. An important requirement of these mixed-signal or mixed-technology SoCs is on-chip electrical isolation. Isolation improves the noise performance of the overall system by reducing the coupling between the various technologies (e.g., power supply coupling).

SOI CMOS compatible solutions are an easy choice for low power SoC design, especially in avionics. Due to the properties associated with SOI technology, it performs much better in a radiation filled environment compared with bulk CMOS technology. Bulk processes are prone to single-event latchup (SEL), single-event upset (SEU), and other effects caused by particle bombardment. SOI technology is immune to SEL and has proven to be ten times less sensitive to SEU than bulk technology. Furthermore, SOI technology offers superior temperature performance over bulk, including functionality up to 800K [1].

With the goal being the high level integration of the aforementioned subsystems onto a single chip, obviously it becomes necessary to have a reliable form of on-chip electrical isolation to avoid noise propagation between different subsystems. One of the major hurdles in current SoC design is the ability to place inductors and transformers on-chip [2]. Usually, on-chip transformers take up a lot of space, on the order of 50,000 μm^2, and the circuits used to drive them consume a considerable amount of power.

One novel solution to a reliable source of data isolation is the use an electrothermal based data isolator. The advantage of using thermal media, as opposed to magnetic, as a means of isolation is the availability of on-chip devices that are able to transmit and receive thermal signals. Also, thermal based transducers are significantly smaller than their magnetic counterparts, usually around 1,600 μm^2 per transducer.

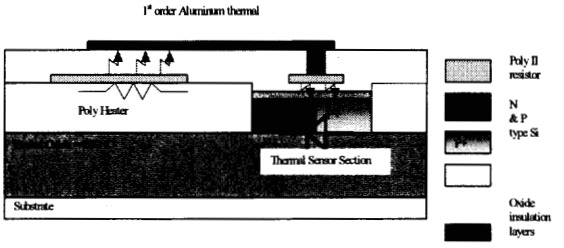

Figure 1. Cross Sectional View of Transducer

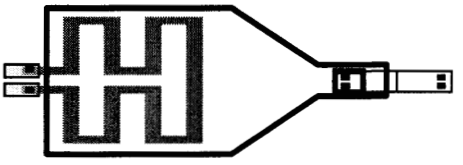

Figure 2. Top View of Transducer

Figure 1 and Figure 2 show a prototype thermal transducer structure that was fabricated in a 0.8 μm SOI CMOS compatible process. Figure 1 shows a cross sectional view of the transducer, where the solid white areas are silicon, the gray area is a poly-silicon resistor, the black area is the aluminum thermal lens, and the dotted area is silicon dioxide. The diode thermal detector is also illustrated.

Figure 2 is a top view of the transducer with the resistor input on the left and the diode output on the right. The thermal lens is outlined in solid black.

In the prototype structures, a poly-silicon resistor is used as a heater to produce a thermal signal from an incident electrical signal. The thermal lens is responsible for gathering the thermal signal and directing it toward the diode thermal detector. The electrically biased diode reproduces an electrical signal at the output as the temperature changes.

References:

[1] J. P. Colinge, *Silicon-On-Insulator Technology.* Norwell, MA: Kluwer, 1997. [2] L. Alkalai, "A Roadmap for Space Microelectronics Technology into the New Millennium," *Proceedings of the 35th Space Congress,* Cocoa Beach, FL, April 1998.